REMARKS

By this amendment, claims 1-10, 12-22, 24-25, 33-45, 56-86 and 89 are pending in this application, of which claims 1, 3-5, 10, 13, 16, 17, 21, 33, 38, 41, 44 58, 62, 66, 70, 74, 78 and 89 are being amended.

The amendments to claims 1, 10, 17, 21, 33, 38, 41, 44 and 89 which recite a "chamber top surface" are supported at least by the Specification at page 9, lines 28-30. The claim amendments were not only earlier entered, because the Examiner's argument to the language "directly above" was not only earlier presented. The amendments to claims 3-5, 13, 16, 58, 62, 66, 70, 74, and 78 are o conform the claims to the amended parent claims.

Thus the claim amendments are fully supported by the Specification and original claims and add no new matter. Accordingly, entry of the claim amendments is respectfully requested.

Reconsideration of the present application is respectfully requested in view of the amendments and arguments made herein.

Claim Rejections Under 35 U.S.C. §103(a)

I. Claims 1-7, 10, 12-22, 33-45, 56-86 and 89 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 5,985,092 issued to Chiu et al. in view of U.S. Patent 5,961,850 issued to Satou et al.

As amended, independent claims 1, 10, 17, 21, 33, 38, 41, 44 and 89 and the claims dependent therefrom, are patentable under 35 U.S.C. 103(a) over Chiu et al. in view of Satou et al., because the cited combination does not establish a *prima facie*

case of obviousness. To establish a *prima facie* case of obviousness under 35 U.S.C. 103(a):

(a) The claimed invention must be considered as a whole;

(b) The references must be considered as a whole and must suggest the desirability and thus the obviousness of making the combination;

(c) The references must be viewed without the benefit of impermissible hindsight vision afforded by the claimed invention; and

(d) Reasonable expectation of success is the standard with which obviousness is determined.

Hodosh v. Block Drug Co., Inc., 786 F.2d 1136, 1143 n.5, 229 USPQ 182, 187 n.5 (Fed. Cir. 1986).

1. The Office Action Does Not Consider the Claimed Invention As a Whole.

To establish obviousness, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). In determining the differences between the prior art and the claims, the question under 35 U.S.C. 103 is not whether the differences <u>themselves</u> would have been obvious, but whether the claimed invention <u>as a whole</u> would have been obvious. *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F. 2d 1530, 218 USPQ 871 (Fed. Cir. 1983).

Neither over Chiu et al. or Satou et al. teach amended claim 1, which is to a method of processing a substrate in which a substrate is provided in a process chamber having a wall that defines a chamber top surface, and a gas is introduced into the process chamber and energized by applying an RF current through a multi-turn antenna above the chamber top surface of the wall of the process chamber to pass RF energy through the wall to the gas inside the process chamber. Radiation is directed onto the substrate surface through the chamber top surface and wall. Radiation

reflected from the substrate is detected from directly above the surface of the substrate after the radiation propagates through the chamber top surface and wall. The detected radiation is collimated and evaluated to monitor the depth of a layer being processed on the substrate.

Chiu et al. does not teach energizing a gas by applying an RF current through a multi-turn antenna above a chamber top surface defined by a wall of the process chamber to pass RF energy through the wall to the gas inside the process chamber to energize the gas. Instead, as noted by the Examiner, Chiu et al. teaches an etching system having coils that surround a sidewall of the chamber, and thus, are not located above a chamber top surface as claimed. Specifically, Chiu et al. teaches:

> "...coils formed of hollow copper tubing around the quartz walls of the etching chamber. The copper coils are provided around the etching chamber to provide an RF field to the interior of the chamber, and completely surround parts of the chamber walls. (Column 2 lines 39-43.) [Emphasis added]

A diagram of the etching chamber, as shown in FIG. 1, and the corresponding description further confirms that in Chiu et al. teaches coils which surround the chamber sidewalls:

> Coils 18 are wound around the walls of the quartz bell jar 12 for applying an electric or magnetic field to the inner chamber to either excite an etchant or to control the properties of an excited etchant....
>
> The coils 18 typically consist of copper or other low resistivity metal tubing wrapped in a shallow spiral around the quartz bell jar...

(Col. 4, lines 50-57). [Emphasis added.]

Thus, Chiu et al. does not teach "applying an RF current through a multi-turn antenna above a chamber top surface of a wall of the process chamber" as claimed in claim 1.

Further, Chiu et al. does not teach directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber as claimed in

claim 1. Instead Chiu et al. teaches that:

> ... The progress of an etching operation can be monitored by tracking either characteristic emissions or absorptions from the materials produced by etching the surface of the workpiece. Other processes, including those listed in the background of the specification, might also be used for detecting the end of a process step.

(Column 5, lines 7-23.) Chiu et al. further teaches "monitoring the intensity of fluorescence or characteristic emissions..." (Col. 1, lines 62-63). However, the characteristic emissions or absorptions, or fluorescence as taught by Chiu et al. are generated from emissions inside the chamber. Thus, these teachings do not read on the claimed process step of "directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber". Chiu et al. does not teach or suggest directing radiation through the chamber top surface and wall of the process chamber, as claimed in claim 1.

Further Chiu et al. does not teach collimating the detected radiation or evaluating the detected collimated radiation. The word "collimated" means "to bring into line; make parallel." www.dictionary.com, Unabridged (v 1.1) (based on the Random House Unabridged Dictionary, © Random House, Inc. 2006). As quoted by the Office Action, Chiu et al. teaches "[i]t may be desirable to provide a lens or other optical elements in association with the end of the optical fiber to collect light to improve the efficiency of the endpoint detection system." However, the action of "collecting" light as taught by Chiu et al. does not mean that Chiu et al. is teaching collimating the radiation, i.e., making the radiation parallel. Light can be collected by a lens without the lens making the light parallel. Thus Chiu et al. does not teach collimating the radiation or evaluating the detected collimated radiation. For these reasons, Chiu et al. does not teach or suggest claim 1 as a whole.

Furthermore, Satou et al. does not cure the deficiencies of Chiu et al. because Satou et al. in combination with Chiu et al. also does not teach claim 1 as a whole. The Office Action cites Satou et al. for teaching "ICP plasma reactors having the

claimed coil configurations (see figures 5 and 7)." However, the present claims are directed to a process and not a chamber or coil configuration. Accordingly, the obviousness rejection must be supported by some teaching in Satou et al. or Chiu et al. to the claimed process as a whole. However, neither Satou et al. nor Chiu et al. teach or suggest a process step which involves "directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber" as claimed. In addition, Chiu et al. and Satou et al. also do not teach collimating the detected radiation and evaluating the detected collimated radiation. Thus clearly, Chiu et al. and Satou et al. do not teach or suggest claim 1 as a whole.

2. Chiu et al. and Satou et al. do not Motivate or Suggest the Desirability of the Claimed Combination.

Under the second part of the obviousness test, the combination of cited references, considered as a whole, must teach or suggest the desirability of the claimed subject matter. To establish a prima facie case of obviousness, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings. *In re Vaeck*, 947 F.2d 488 (Fed. Cir. 1991). See also MPEP § 2143 - § 2143.03.

As acknowledged by the Office Action, Chiu et al. does not teach detecting radiation from directly above the substrate with a particular coil configuration being claimed. However, in addition, Chiu et al. does not teach directing radiation onto the substrate surface from directly above the substrate and through the chamber top surface and wall of the process chamber. Chiu et al. further does not teach collimating the detected radiation. Chiu et al. also does not teach evaluating the detected collimated radiation.

Satou et al. teaches chambers having various coil configurations. However, Satou et al does not teach or suggest "directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber" as claimed.

Satou et al. also does not teach "detecting radiation reflected from the substrate from directly above the surface of the substrate after the radiation propagates through the chamber top surface and wall" as claimed. Satou et al. further does not teach collimating the detected radiation and evaluating the detected collimated radiation.

Further, in suggesting the combination, the Office Action has not explained why one of ordinary skill in the art would be motivated to modify the process taught by Chiu et al. to apply a chamber design taught by Satou et al. There is no teaching or suggestion in Chiu et al or Satou et al. that would motivate one of ordinary skill in the art to apply the process monitoring system taught by Chiu et al. to the type of chamber and external antenna taught by Satou et al.. In fact, since Chiu et. al. teaches that detecting radiation is a problem even when the antenna coil surrounds sidewalls of the chamber, one would be motivated against applying an antenna that is above the external surface of the chamber and in the path of monitoring the endpoint signal from directly above the substrate, as claimed. Placing the antenna taught by Satou et al. in the path of the radiation and optical fiber taught by Chiu et al. might make Chiu et al. rather upset, as now it would be even more difficult for Chiu et al. to detect the radiation at the location chosen by Chiu et al. which is in the same region of the chamber. Thus one of ordinary skill in the would not be motivated to apply the coil configurations taught by Satou et al. to the fluorescence/emission endpoint method taught by Chiu et al. to derive the present claims. Thus Applicants respectfully submits that Chiu et al. and Satou et al. do not motivate derivation of present claims.

3. The Combination of Chiu et al. and Satou et al. Does Not Have a Reasonable Expectation of Success Absent Hindsight Knowledge.

Furthermore, the endpoint detection process derived by the combination of Chiu et al. and Satou et al. does not necessarily have a reasonable expectation of success based on the teachings of Chiu et al. and Satou et al., and without the hindsight knowledge derived from Applicant's invention. Chiu et al. does not teach energizing a gas by applying an RF current through a multi-turn antenna above a

chamber top surface defined by a wall of the process chamber to pass RF energy through the wall to the gas inside the process chamber to energize the gas. Instead, Chiu et al. teaches an etching system having coils around a sidewall portion of the chamber and not above a chamber top surface. Chiu et al. also does not teach directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber, as claimed in claim 1 Instead Chiu et al. teaches monitoring fluorescence or characteristic emissions which are generated by the fluorescence or emissions of radiation from material inside the chamber, and thus are not directed onto the substrate surface through the chamber top surface and wall of the process chamber. Further, Chiu et al. also does not teach collimating the detected radiation and evaluating the detected collimated radiation. Light can be collected by a lens as taught by Chiu et al. without the lens making the light parallel.

Satou et al. teaches chambers having various coil configurations. However, Satou et al. also does not teach or suggest “directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber” as claimed. Nor does Satou et al. teach “detecting radiation reflected from the substrate from directly above the surface of the substrate after the radiation propagates through the chamber top surface and wall” as claimed. Satou et al. also does not teach collimating the detected radiation and evaluating the detected collimated radiation.

Thus modifying the process taught by Chiu et al. by applying a chamber design taught by Satou et al. would not necessarily have a reasonable expectation of success. The process monitoring system taught by Chiu et al. may not work with the chamber design or external antenna taught by Satou et al.. For example, would the Satou et al. chamber create fluorescent or other emissions that can be then detected in Chui et al.’s method? Further Chiu et. al. indicates that detecting the radiation emissions generated in the chamber is more difficult when the antenna coil surrounds sidewalls of the chamber. Thus placing an antenna above the external surface of the chamber as taught by Satou et al. would further exacerbate this problem. Thus it is likely that the combination of the fluorescence/emission endpoint method taught by Chiu

et al. with the antenna configurations taught by Satou et al. would generate a process which has a reasonable expectation of success, absent the knowledge gained from Applicant's own invention.

The claimed process solves the problem of monitoring the endpoint of a process conducted in a chamber in which gases are energized by coupling RF energy from above a chamber top surface and through the wall of the chamber. Because the RF energy is being coupled from outside the chamber, the energy coupling step interferes with the step of monitoring the endpoint of the process, which is also being conducted through the same top surface and chamber wall. Applicant has devised an elegant solution to this problem by directing radiation onto the substrate surface through the chamber top surface and wall while also detecting radiation reflected from the substrate from directly above the surface of the substrate as recited in claim 1. Further, the signal-to-noise ratio of the reflected radiation is improved by collimating the detected radiation and evaluating the detected collimated radiation. This process and the advantages obtained therefrom, are not taught or suggested by the combination of Chiu et al. and Satou et al.. Only in hindsight and coupled with the knowledge gleaned from Applicant's disclosure can the claimed combination be reconstructed based on selective extraction of sections of each reference, and combining these sections to derive the claimed invention without considering the claim as a whole, or the teachings of each reference as a whole.

For these reasons, respectfully submits that Chiu et al. and Satou et al. do not render claim 1 obvious.

The combination of Chiu et al. and Satou et al. also does not teach or suggest claim 10 because the cited references do not teach or suggest directing radiation onto the substrate surface from directly above the surface of the substrate and through the chamber top surface and wall of the process chamber; detecting radiation reflected from the substrate from directly above the surface of the substrate after the radiation propagates through the chamber top surface and wall; collimating the detected

radiation; and evaluating the detected collimated radiation, as claimed in claim 10.

Claim 17 is also not taught or suggested by the combination of Chiu et al. and Satou et al., because the cited references do not teach "directing radiation onto the substrate surface from above the at least partially domed chamber top surface of the chamber; monitoring radiation reflected from the substrate from directly above a surface of the substrate after the radiation propagates through the at least partially domed chamber top surface during processing of the substrate; collimating the detected radiation; and evaluating the monitored collimated radiation..." as claimed in claim 17.

Claim 21 is also not taught or suggested by the combination of Chiu et al. and Satou et al., because the cited references do not teach "directing radiation onto the substrate surface from directly above the surface of the substrate and through the chamber top surface of the process chamber; collimating and monitoring radiation from directly above the surface of the substrate from after the radiation has propagated through the portion of the chamber top surface of the first enclosure facing the substrate and into a second enclosure disposed above the first enclosure; and evaluating the detected collimated radiation..." as recited in claim 21.

The combination of Chiu et al. and Satou et al. also does not teach or suggest claim 33 because references do not teach directing radiation onto the substrate surface from directly above the surface of the substrate and through the chamber top surface and wall of the process chamber; detecting radiation reflected from the substrate and propagating through the wall; collimating the directed and detected radiation; and evaluating the detected and collimated radiation, as recited in claim 33.

Claim 38 is also not taught or suggested by the combination of Chiu et al. and Satou et al., because the cited references do not teach directing radiation onto the substrate surface through the chamber top surface of the chamber; monitoring radiation reflected from the substrate and that propagates through the portion of the chamber top surface; collimating the monitored radiation; and evaluating the monitored radiation..."

as recited in claim 38.

Claim 41 is also not taught or suggested by the combination of Chiu et al. and Satou et al., because the cited references do not teach directing radiation across the flat wall of the chamber; detecting radiation that propagates through the chamber top surface and flat wall; collimating the detected radiation; and evaluating the detected collimated radiation, as recited in claim 41.

The combination of Chiu et al. and Satou et al. also does not teach or suggest claim 44, because the references do not teach directing radiation onto the substrate surface through the chamber top surface and wall of the chamber; detecting radiation reflected from the substrate and that propagates through the chamber top surface and wall; collimating the monitored radiation; and evaluating the detected collimated radiation, as claimed in claim 44.

The combination of Chiu et al. and Satou et al. also does not teach or suggest claim 89, because the references do not teach "directing radiation onto the substrate through the chamber top surface and wall facing the substrate; detecting radiation reflected from the substrate and that propagates through the chamber top surface and wall using a monitoring assembly abutting the chamber top surface of the wall of the chamber; collimating the detected radiation; and evaluating the detected collimated radiation ..." as recited in claim 89.

For these reasons, Chiu et al. and Satou et al. do not render obvious the present claims.

II. Claims 8, 9, 24 and 25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Chiu and Satou as applied to claims 1 and 21, and further in view of U.S. Patent 5,691,540 issued to Halle et al.

Claims 8 and 9 are dependent on claim 1, and the combination of Chiu et al. and Satou et al. does not teach or suggest claim 1, for the same reasons as those cited above. Specifically, Chiu et al. and Satou et al. do not teach applying an RF current through a multi-turn antenna above a chamber top surface of a wall of the process chamber to pass RF energy through the wall to the gas inside the process chamber to energize the gas; directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber; detecting radiation reflected from the substrate from directly above the surface of the substrate and after the radiation propagates through the chamber top surface and wall; collimating the detected radiation; and evaluating the detected collimated radiation to monitor the depth of a layer being processed on the substrate, as recited in claim 1.

The Examiner indicates that Halle et al. teaches "a plasma process monitoring apparatus that includes a collimating lens and a bifurcated optical cable with [one] end being connected to the signal source and one end being connected to the signal detector,"

However, Halle et al. does not teach energizing a gas by applying an RF current through a multi-turn antenna above a chamber top surface of a wall of the process chamber to pass RF energy through the wall to the gas inside the process chamber to energize the gas. Applicant's claim 1 is directed to monitoring a process while current is being passed through a multi-turn antenna above a chamber top surface of a wall of the chamber. Halle et al. does not teach this step, and consequently, does not disclose the claimed process and its advantages.

The present claims are directed to solving the problem of monitoring the endpoint of a process being conducted in a chamber in which gases are energized by

coupling RF energy through the wall of the chamber. Because the RF energy is being coupled from outside the wall into the chamber, the energy coupling step interferes with the step of monitoring the endpoint of the process, which is also being conducted through the same wall. Applicant has devised an elegant solution to this problem by directing radiation onto the substrate surface through the chamber top surface and wall of the process chamber while also detecting radiation reflected from the substrate from directly above the surface of the substrate after the radiation propagates through the chamber top surface and wall as recited in claim 1. Further, the signal-to-noise ratio of the reflected radiation is improved by collimating the detected radiation and evaluating the detected collimated radiation. These processes, or the advantages obtained therefrom, are not taught or suggested by the combination of Chiu et al., Satou et al. and Halle et al.. Only in hindsight and coupled with the knowledge gleaned from Applicant's disclosure can the claimed combination be reconstructed based on selective extraction of individual sections of each reference, and combining these sections to derive the claimed invention without considering the teachings of each reference as a whole. For these reasons, claims 8 and 9 are not obvious over the cited references.

Claims 24 and 25 are dependent on claim 21, and the combination of Chiu et al. and Satou et al. does not teach or suggest claim 21, for the reasons cited above. Specifically, Chiu et al. and Satou et al. do not teach directing radiation onto the substrate surface thorough a chamber top surface of the process chamber; collimating and monitoring radiation from directly above the surface of the substrate from after the radiation has propagated through the portion of the chamber top surface of the first enclosure facing the substrate and into a second enclosure disposed above the first enclosure; and evaluating the detected collimated radiation to monitor the depth of a layer being processed on the substrate to determine a process endpoint, as recited in claim 21.

Furthermore, Halle et al. does not make up for the deficiencies of Chiu et al. and Satou et al. because Halle et al. also does not teach applying an RF current through a multi-turn antenna to pass RF energy from outside an chamber top surface of

a first enclosure facing the substrate to the process gas to energize process gas inside the first enclosure, as claimed in claim 21. Further, Halle et al. does not teach or suggest the problem of monitoring the endpoint of a process being conducted in the chamber through the chamber top surface through which RF energy is passed from outside the chamber. As explained, the antenna or coil occupies space above the top surface and reduces ease in monitoring the process because of the space occupied by the antenna. To solve this problem, Applicant directs radiation onto the substrate surface through the chamber top surface, and also collimates and monitors radiation from directly above the surface of the substrate after the radiation has propagated through the chamber top surface. The detected collimated radiation provides a higher signal-to-noise ratio. The advantages of the present process are simply not taught or suggested by the combination of Chiu et al., Satou et al. and Halle et al.. For these reasons, claims 24 and 25 are not obvious over the cited references.

The above-discussed amendments are believed to place the present application in condition for allowance. Should the Examiner have any questions regarding the above remarks, the Examiner is requested to telephone Applicant's representative at the number listed below.

Respectfully submitted,

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